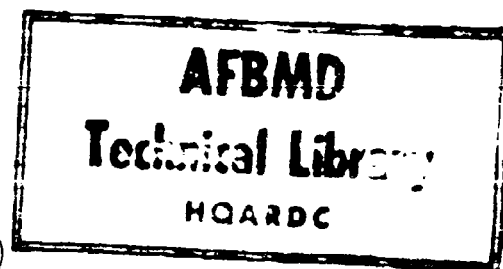


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PROJECT RAND

RED STAR SERIES ON ATOMIC WEAPONS
AND ANTIATOMIC DEFENSE

F. J. Krieger

T-41

Part II

4 August 1954

"Atomic Weapons and Antiatomic Defense"

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In January, 1954, the Soviet Ministry of Defense organ Krasnaya Zvezda (Red Star) began publishing a series of signed articles on atomic energy. The articles are of an elementary nature and were presumably intended to give the lay reader a basic background for understanding not only the military effects of atomic weapons but also the practical applications of atomic energy. Translations of these articles are available in the RAND T-55 series.

Herewith is presented a translation of the second article in the Red Star series generally entitled "'Atomic Weapons and Antiatomic Defense,'" the second of three by Professor B. Olisov. The importance of these articles from a military point of view is manifest by the fact that they were transmitted by radio broadcast to the Soviet Armed Forces in the Far East. The broadcasts were intercepted by U. S. monitors during the latter part of August.

Other articles in this series will be presented in order as they become available. Since the content of the articles may be of interest to persons in various fields, a complete translation of this series may serve a useful purpose.

P. J. Krieger

ATOMIC WEAPONS AND ANTIATOMIC DEFENSE*

2.

Antiatomic defense of troops represents a rather complicated system and is not limited only to measures for the erection of various installations for the direct protection of personnel and equipment from the effect of atomic weapons. Our country and her Armed Forces have a complete system of measures, the essence of which consists in guarding the population and also the troops, as reliably as possible, against a surprise atomic attack, and, in case of necessity, in providing the Army and Navy an opportunity to successfully carry out combat operations to crush the aggressor.

We shall not dwell on all the questions of antiatomic defense, however, since, after all, this is not our task. Let us note only that the present state of antiatomic defense (the combination of all measures and means) permits us, with sufficient reliability, to protect troops against attack and, in case of necessity, to defend them against the effect of atomic weapons. It is precisely the latter side of the question which will be the subject of our consideration.

First of all, let us examine the question of the defense of troops against the effect of the shock wave. It is known that about half of the total energy of the explosion is expended in forming the shock wave. From this it follows that the air shock wave is the most powerful damaging factor of an atomic bomb [explosion].

In order to better understand the effect of the shock wave on objects and objectives, let us briefly examine the physical phenomenon of the shock wave

Continuation. For beginning see Krasnaya Zvezda for 3 August 1954

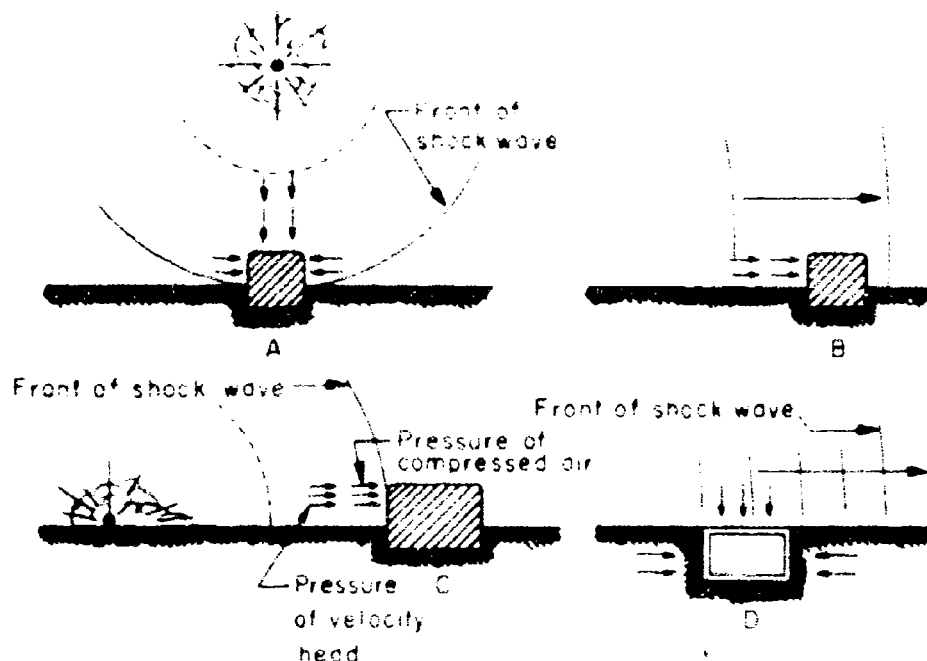
*Krasnaya Zvezda, 4 August 1954, p. 2

Like the shock wave formed by the explosion of ordinary explosives, the shock wave of an atomic explosion is a zone of strongly compressed air. The compression, passing from one layer of air to another, spreads rapidly in the atmosphere. The velocity of propagation of the front of the shock wave exceeds the speed of sound, and, for bombs of medium caliber, at distances of 0.5 to 1 kilometer from the point of explosion, it is equal to 500 to 1000 meters per second. The velocity of the front decreases with distance from the point of explosion, and, at distances of 15 to 16 kilometers, reduces to the velocity of sound - 340 meters per second. From this moment the shock wave degenerates into a sound wave and is heard as a distant clap of thunder.

The particles of air within the compressed zone, that is, in the shock wave, also move away from the center of explosion. The displacement of the air particles near the point of explosion is felt as a tremendous wind pressure and is called the pressure head.

The pressure in the undisturbed atmosphere ahead of the shock wave front is equal to the atmospheric. The pressure increases sharply and in jumps and attains its greatest magnitude on the front. Behind the wave front the pressure gradually diminishes, reaches atmospheric, and then becomes less than atmospheric. The region, in which the pressure is less than atmospheric, is called a zone of rarefaction or suction. In a suction zone the particles of air move toward the center of explosion.

Installations, on which a shock wave acts, may be either in the zone of a wave falling from above (see Fig. A), if they are located near the point of explosion of an atomic bomb in the air, or in the zone of a wave which glides along the ground (see Fig. B), if they are located far from the center of explosion. In an explosion of an atomic bomb on the ground, a gliding shock wave spreads out over the entire surface of the ground (see Fig. C).



If a wave falls on an installation from above, the structure undergoes an especially strong reaction, since it is in a zone of highly compressed air which compresses it on all sides; moreover, the pressure head of air particles moving from above acts on the roof. The front wall of any structure in the zone of the gliding wave undergoes such a double loading from the pressure of the compressed air and the pressure head.

An installation even shallowly entrenched in the ground experiences considerably less pressure than an installation which rises above the surface of the ground. This, in particular, explains the fact that the slit trenches and dug-out shelters built by the inhabitants of the cities of Hiroshima and Nagasaki for protection against conventional aerial bombs proved to be relatively stable even under the action of the shock wave from the atomic explosions.

Only the pressure of compressed air from the gliding wave (see Fig. D)

acts on the overhead cover of an entrenched installation, pressure from the pressure head is absent. The ground is compressed under the influence of the shock wave and reduces the transmitted pressure. The lateral pressure on the walls of shallowly entrenched installations is approximately one-third the air pressure on the surface of the ground.

As the entrenchment of an installation increases the pressure is gradually reduced by the ground more and more. One practical conclusion follows from all this: protection from the effect of the shock wave is provided by entrenchments, trenches, communication trenches, recesses, blinds, shelters and various covers for military equipment. Of course, groundworks require great effort and much time of troops and often cannot be achieved in certain combat situations. In such cases one should in every way make use of the protective properties of the terrain. For example, forests, ravines, ditches and the reverse slopes of hills possess good protective properties. One should by all means utilize the shielding effect of objects to protect both equipment and personnel. In Nagasaki, for example, thanks to the shielding effect of hills, buildings located on their reverse slopes suffered considerably less than, say, buildings which were in open terrain.

As far as a man is concerned, in open terrain he can always find a protecting object, say, a ditch or a shell-hole. But if there is none, one should simply lie face down on the ground, with feet toward the explosion. It has been determined that a man, subjected to the effect of a pressure of 0.4 atmosphere, does not lose his fighting ability. Standing in open terrain, however, he can be thrown by the pressure head and will be injured on striking the ground or some other surrounding objects. A man in a prone position represents a barrier in the path of the shock wave one-fifth that of a man standing. Therefore, it is considerably safer to lie on the ground during the action of a shock wave than to stand. After seeing the flash of the

explosion one has time to lie down on the ground or, if there is a shelter nearby, to hide in it, because the shock wave travels from the point of explosion to a distance of 1000 meters in approximately two seconds and to a distance of 2000 meters in five seconds. This is enough time for taking protective measures.

In organizing measures for protecting troops from the effect of the shock wave it is necessary to bear in mind the following circumstance: one should not without necessity deploy them in the open populated points, since the shock wave has not only a direct but also an indirect effect on people. People can sustain serious injuries from the debris of buildings and installations which are being demolished.

Thus, in the atomic bomb explosions over the Japanese cities, the direct effect of the shock wave was not the chief cause for the death and injury of people. The indirect effect of the shock wave played the chief role. It [is precisely this indirect effect which] caused the injury of people at considerable distances. Although serious injuries for this very reason occurred at a distance of only 2000 meters, cases were noted of injury to people by fragments of buildings at a distance up to 3200 meters from the epicenter of the explosion in Hiroshima and up to 3700 meters in Nagasaki. But, on the other hand, the direct effect of the shock wave did not injure people at shorter distances from the epicenter of the explosion. In Hiroshima, for example, people who were on a dam 800 meters from the epicenter were only thrown into the water.

Basements with strong reinforced-concrete or vaulted ceilings should be used as shelters for troops in cities and populated points. As war experience has shown, basements possess great stability and are not destroyed even when the buildings themselves are destroyed. The greater stability of basements is

due to the fact that the upper portions of a building, although destroyed by the explosion, protect the ceilings of the basement from the direct effect of the shock wave. While stationed in populated points, troops must always have broad avenues of evacuation from possible zones of obstructions and fires.

Interior quarters must be used as shelters for the personnel of Navy vessels. It must be acknowledged that of all vessels the submarine best withstands the pressures created by the shock wave from the air explosion of an atomic bomb. This is explained by the fact that the submarine hull is designed to withstand considerable pressures and the submarine itself is rather small and has a specific shape. In an atomic bomb test by the Americans at Bikini one submarine was in the surfaced position at a distance of 450 meters from the epicenter of the explosion (closer than all other vessels), but its hull, machinery and equipment did not suffer heavy damage.

Thus, the shock wave is the basic damaging factor in an atomic explosion. The examples we have cited, however, show that with proper training of troops and the skillful use of protective measures it is possible to greatly reduce or entirely eliminate the effect of the shock wave on people and equipment. To increase protection both against the shock wave and against the other damaging factors of an atomic explosion it is recommended that the individual sectors of trenches and communication trenches, in which troops are situated, be covered over from above with poles or logs, and the slopes reinforced with poles, boards or brushwood.

A still greater degree of protection is achieved if both entrances to a covered trench are closed with shields. The shields should be located in adjacent legs of trenches, at the turns, so that fragments of the shields, during their destruction by the shock wave, do not injure the people in the trench. In parapetted blinds and shelters special attention should be paid to the strength of the overhead cover, since the effect of the shock wave on it

is considerably greater than the lateral pressure transmitted through the ground to the walls.

Such, in brief, are the most accessible measures which troops must make use of in order to keep personnel and equipment from the damaging effect of the shock wave, and so maintain the capacity for energetic and decisive action in destroying the enemy.

While learning the measures of protection against the damaging effect of atomic weapons, our soldiers must at the same time not forget that under any circumstances, especially under conditions of the use of atomic weapons, victory will be on the side of those who act energetically and decisively, who, despite all difficulties and dangers, strive honorably to carry out the combat task and to crush the enemy.

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